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## Digital Natives, Digital Immigrants Part 2: Do They Really Think Differently?

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*Different kinds of experiences lead to different brain structures.*

Dr Bruce D. Berry,  
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Our children today are being socialized in a way that is vastly different from their parents. The numbers are overwhelming: over 10,000 hours playing videogames, over 200,000 e-mails and instant messages sent and received; over 10,000 hours talking on digital cell phones; over 20,000 hours watching TV (a high percentage fast speed MTV), over 500,000 commercials seen – all before the kids leave college. And, maybe, at the very most, 5,000 hours of book reading. These are today's "Digital Native" students.<sup>1</sup> (Notes can be found at [www.twitchspeed.com/site/blank2.html](http://www.twitchspeed.com/site/blank2.html))

In *Digital Natives, Digital Immigrants Part 1*, I discussed how the differences between our Digital Native students and their Digital Immigrant teachers lie at the root of a great many of today's educational problems. I suggested that Digital Natives' brains are likely to be physically different as a result of the digital input they received when growing

up. And I submitted that learning via digital games is one good way to reach Digital Natives in their "native language."

Here I present evidence for why I think this is so. It comes from neurobiology, social psychology, and from studies done on children using games for learning.

### Neuroplasticity

Although the vast majority of today's educators and teachers grew up with the understanding that the human brain doesn't physically change based on stimulation it receives from the outside – especially after the age of three, it turns out that that view is, in fact, incorrect.

Based on the latest research in neurobiology, there is no longer any question that stimulation of various kinds actually changes brain structures and affects the way people think, and that these transformations go on throughout life. The brain is, to an extent not at all understood or believed when Baby Boomers were growing up, to be massively plastic. It can be, and is, constantly reorganized. (Although the popular term "rewired" is somewhat misleading, the overall idea is right – the brain changes and organizes itself differently, based on the inputs it receives.)

*continued on page 3*

### IN THIS ISSUE:

*Digital Natives, Digital Immigrants Part 2: Do They Really Think Differently?*

Marc Prensky . . . . . 1

### From the Editor

*The Intelligent Use of Information*

Tom P. Abeles . . . . . 2

*The Scholar's Forum Débuts*

Richard C. Flagan and Anne M. Buck . . 7

*Unplugged Classrooms: Are Chalk-talks Still in Play?*

Daniel Neal Graham . . . . . 10

### Tracking Technology

*A Column to Keep You Abreast of the Onrushing Knowledge Revolution*

William E. Halal . . . . . 12

### Scanning the Environment

*"McDonald's" of IT Training World-wide Growing Fast*

George Lorenzo . . . . . 14

*INTI Expansion Effort Includes E-Campuses*

George Lorenzo . . . . . 15

*Call for papers* . . . . . 16

Thus, The Academy's alarm has rung several times within the last few years. Yet most institutions, from faculty to boards of directors, seem to have seen these signals as either false alarms or insignificant "readings" on the planning boards. Some of these indicators are:

- A change is happening in the student population and the expectations within the traditional knowledge delivery system.
- The marketplace has spawned a variety of competitive alternatives and complements to the traditional institution.
- Global networks are promoting inter-institutional exchanges of credits and courses well beyond what is happening at a local or regional level.
- The "textbook" industry is being transformed into a packaged course delivery industry brokering courses to traditional institutions.
- Geographically protected markets are being globalized, forcing institutions into the international marketplace.

Scanning the sea of information, so that one can flow with the tide, works well in times of great stability. Because the body of knowledge was relatively stable and all parties had clear expectations of what a college experience provided, it made little difference that the institutional ship did not respond quickly to the administrative helm. Today there must be a clear vision; otherwise the ship will continue on the same path or the persons at the helm will be driven to respond to the whimsy of incoming reports.

A number of psychologists have pointed out that, when we run into a barrier, we return to a period where we experienced "growth" or felt a positive movement. The Academy may be in this position, where it is grasping at larger and larger bodies of information with ever more powerful sorting and analysis programs and more charts to try to find the directional needle in the data haystack. This occurs at all levels from faculty research to mapping the direction of the ship of state. Or we peer at all of our colleagues to determine who has broken a new path and raised the safety ropes so that others might follow. The model, of course, is that of traditional innovation; the innovators are followed by the early adopters; and the new path is created. What happens in a world where this model may be fading? Knowledge transfer is Lamarckian. Information flows across generations and contemporaries in contrast with Darwin's genetic model, which only carries forward through inheritance.

It has been argued that the more things change, the more they remain the same. It is hard to imagine that the cloistered halls of academia aren't permanently enshrined in the historic register of intellectual properties and that the evolution resides in the archives of knowledge. Any thoughts? ●

## Digital Natives, Digital Immigrants

### Part 2: Do They Really Think Differently?

*continued from page 1*

The old idea that we have a fixed number of brain cells that die off one by one has been replaced by research showing that our supply of brain cells is replenished constantly.<sup>2</sup> The brain constantly reorganizes itself all our child and adult lives, a phenomenon technically known as neuroplasticity.

***The understanding that the human brain doesn't physically change, based on stimulation it receives from the outside, is, in fact, incorrect***

One of the earliest pioneers in this field of neurological research found that rats in "enriched" environments showed brain changes compared with those in "impoverished" environments after as little as two weeks. Sensory areas of their brains were thicker, other layers heavier. Changes showed consistent overall growth, leading to the conclusion that the brain maintains its plasticity for life.<sup>3</sup>

Other experiments leading to similar conclusions include the following:

- Ferrets' brains were physically rewired, with inputs from the eyes switched to where the hearing nerves went and vice versa. Their brains changed to accommodate the new inputs.<sup>4</sup>
- Imaging experiments have shown that, when blind people learn Braille, "visual" areas of their brains light up. Similarly, deaf people use their auditory cortex to read signs.<sup>5</sup>
- Scans of brains of people who tapped their fingers in a complicated sequence that they had practiced for weeks showed a larger area of motor cortex becoming activated than when they performed sequences they hadn't practiced.<sup>6</sup>
- Japanese subjects were able learn to "reprogram" their circuitry for distinguishing "ra" from "la," a skill they "forget" soon after birth, because their language doesn't require it.<sup>7</sup>
- Researchers found that an additional language learned later in life goes into a different place in the brain from the language or languages learned as children.<sup>8</sup>
- Intensive reading instruction experiments with students aged ten and up appeared to create lasting chemical changes in key areas of the subjects' brains.<sup>9</sup>

- A comparison of musicians' versus non-players' brains via magnetic resonance imaging showed a 5 percent greater volume in the musicians' cerebella, ascribed to adaptations in the brain's structure resulting from intensive musical training and practice.<sup>10</sup>

We are only at the very beginning of understanding and applying brain plasticity research. The goal of many who are – such as the company Scientific Learning – is “neuroscience-based education.”<sup>11</sup>

### **Malleability**

Social psychology also provides strong evidence that one's thinking patterns change depending on one's experiences. Until very recently Western philosophers and psychologists took it for granted that the same basic processes underlie all human thought. While cultural differences might dictate what people think about, the strategies and processes of thought, which include logical reasoning and a desire to understand situations and events in linear terms of cause and effect, were assumed to be the same for everyone. However this, too, appears to be wrong.

Research by social psychologists<sup>12</sup> shows that people who grow up in different cultures do not just think about different things, they actually think differently. The environment and culture in which people are raised affects and even determines many of their thought processes.

### **Social psychology also provides strong evidence that one's thinking patterns change depending on one's experiences**

“We used to think that everybody uses categories in the same way, that logic plays the same kind of role for everyone in the understanding of everyday life, that memory, perception, rule application and so on are the same,” says one. “But we're now arguing that cognitive processes themselves are just far more malleable than mainstream psychology assumed.”<sup>13</sup>

We now know that brains that undergo different developmental experiences develop differently, and that people who undergo different inputs from the culture that surrounds them think differently. And, while we haven't yet directly observed Digital Natives' brains to see whether they are physically different (such as musicians' appear to be), the indirect evidence for this is extremely strong.

However, brains and thinking patterns do not just change overnight. A key finding of brain plasticity research is that brains do not reorganize casually, easily or arbitrarily. “Brain reorganization takes place only

when the animal pays attention to the sensory input and to the task.”<sup>15</sup> “It requires very hard work.”<sup>14</sup> Biofeedback requires upwards of 50 sessions to produce results.<sup>16</sup> Scientific Learning's Fast ForWord program requires students to spend 100 minutes a day, five days a week, for five to ten weeks to create desired changes, because “it takes sharply focused attention to rewire a brain.”<sup>17</sup>

### **A key finding of brain plasticity research is that brains do not reorganise casually, easily or arbitrarily**

Several hours a day, five days a week, sharply focused attention – does that remind you of anything? Oh, yes – video games! That is exactly what kids have been doing ever since Pong arrived in 1974. They have been adjusting or programming their brains to the speed, interactivity, and other factors in the games, much as boomers' brains were programmed to accommodate television, and literate man's brains were reprogrammed to deal with the invention of written language and reading (where the brain had to be retrained to deal with things in a highly linear way.)<sup>18</sup> “Reading does not just happen, it is a terrible struggle.”<sup>19</sup> “Reading [has] a different neurology to it than the things that are built into our brain, like spoken language.”<sup>20</sup> One of the main focuses of schools for the hundreds of years since reading became a mass phenomenon has been retraining our speech-oriented brains to be able to read. Again, the training involves several hours a day, five days a week, and sharply focused attention.

Of course just when we'd figured out (more or less) how to retrain brains for reading, they were retrained again by television. And now things have changed yet again, and our children are furiously retraining their brains in even newer ways, many of which are antithetical to our older ways of thinking.

Children raised with the computer “think differently from the rest of us. They develop hypertext minds. They leap around. It's as though their cognitive structures were parallel, not sequential.”<sup>21</sup> “Linear thought processes that dominate educational systems now can actually retard learning for brains developed through game and Web-surfing processes on the computer.”<sup>22</sup>

Some have surmised that teenagers use different parts of their brain and think in different ways from adults when at the computer.<sup>23</sup> We now know that it goes even further – their brains are almost certainly physiologically different. But these differences, most observers agree, are less a matter of kind than a difference of degree. For example, as a result of repeated experiences particular brain areas are larger and more highly developed, and others are less so.

For example, thinking skills enhanced by repeated exposure to computer games and other digital media include reading visual images as representations of three-dimensional space (representational competence), multidimensional visual-spatial skills, mental maps, “mental paper folding” (i.e. picturing the results of various origami-like folds in your mind without actually doing them), “inductive discovery” (i.e. making observations, formulating hypotheses and figuring out the rules governing the behavior of a dynamic representation), “attentional deployment” (such as monitoring multiple locations simultaneously), and responding faster to expected and unexpected stimuli.<sup>24</sup>

***Some have surmised that teenagers use different parts of their brain and think in different ways from adults when at the computer***

While these individual cognitive skills may not be new, the particular combination and intensity are. We now have a new generation with a very different blend of cognitive skills than its predecessors – the Digital Natives.

***What About Attention Spans?***

We hear teachers complain so often about the Digital Natives’ attention spans that the phrase “the attention span of a gnat” has become a cliché. But is it really true?

“Sure, they have short attention spans – for the old ways of learning,” says a professor.<sup>25</sup> Their attention spans are not short for games, for example, or for anything else that actually interests them. As a result of their experiences Digital Natives crave interactivity – an immediate response to their each and every action. Traditional schooling provides very little of this compared with the rest of their world (one study showed that students in class ask a question every ten hours).<sup>26</sup> So it generally isn’t that Digital Natives can’t pay attention, it’s that they choose not to do so.

Research done for *Sesame Street* reveals that children do not actually watch television continuously, but “in bursts.” They tune in just enough to get the gist and to be sure that it makes sense. In one key experiment, half the children were shown the program in a room filled with toys. As expected, the group with toys was distracted and watched the show only about 47 percent of the time as opposed to 87 percent in the group without toys. But when the children were tested for how much of the show they remembered and understood, the scores were exactly the same. “We were led to the conclusion that the five-year-olds in the toys group were attending quite strategically, distributing their attention

between toy play and viewing, so that they looked at what was for them the most informative part of the program. The strategy was so effective that the children could gain no more from increased attention.”<sup>27</sup>

***What Have We Lost?***

Still, we often hear from teachers about increasing problems their students have with reading and thinking. What about this? Has anything been lost in the Digital Natives’ “reprogramming” process?

One key area that appears to have been affected is reflection. Reflection is what enables us, according to many theorists, to generalize, as we create “mental models” from our experience. It is, in many ways, the process of “learning from experience.” In our twitch-speed world, there are less and less time and opportunity for reflection, and this development concerns many people. One of the most interesting challenges and opportunities in teaching Digital Natives is to figure out and invent ways to include reflection and critical thinking in the learning (either built into the instruction or through a process of instructor-led debriefing) but still do it in the Digital Native language. We can and must do more in this area.

Digital Natives accustomed to the twitch-speed, multitasking, random-access, graphics-first, active, connected, fun, fantasy, quick-payoff world of their video games, MTV, and Internet are bored by most of today’s education, well meaning as it may be. But worse, the many skills that new technologies have actually enhanced (e.g. parallel processing, graphics awareness, and random access) – which have profound implications for their learning – are almost totally ignored by educators.

***We often hear from teachers about increasing problems their students have with reading and thinking***

The cognitive differences of the Digital Natives cry out for new approaches to education with a better “fit.” And, interestingly enough, it turns out that one of the few structures capable of meeting the Digital Natives’ changing learning needs and requirements is the very video and computer games they so enjoy. This is why “Digital Game-Based Learning” is beginning to emerge and thrive.

***But Does It Work?***

Of course many criticize today’s learning games, and there is much to criticize. But, if some of these games don’t produce learning, it is not because they are games, or because the concept of “game-based learning” is

faulty. It's because those particular games are badly designed. There is a great deal of evidence that children's learning games that are well designed do produce learning, and lots of it – by and while engaging kids.

While some educators refer to games as “sugar coating,” giving that a strongly negative connotation – and often a sneer, it is a big help to the Digital Natives. After all, this is a medium with which they are very familiar and which they really enjoy.

Elementary school, when you strip out the recesses and the lunch and the in-between times, actually consists of about three hours of instruction time in a typical 9 to 3 day.<sup>28</sup> So assuming, for example, that learning games were only 50 percent educational, if you could get kids to play them for six hours over a weekend, you'd effectively add a day a week to their schooling! Six hours is far less than a Digital Native would typically spend over a weekend watching TV and playing videogames. The trick, though, is to make the learning games compelling enough to actually be used in their place. They must be real games, not just drill with eye-candy, combined creatively with real content.

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The numbers back this up. The Lightspan Partnership, which created PlayStation games for curricular reinforcement, conducted studies in over 400 individual school districts and a “meta-analysis” as well. Their findings were increases in vocabulary and language arts of 24 and 25 percent respectively over the control groups, while the math problem-solving and math procedures and algorithms scores were 51 and 30 percent higher.<sup>29</sup>

Click Health, which makes games to help kids self-manage their health issues, did clinical trials funded by the National Institutes of Health. They found, in the case of diabetes, that kids playing their games (compared with a control group playing a pin-ball game) showed measurable gains in self-efficacy, communication with parents and diabetes self-care. And more importantly, urgent doctor visits for diabetes-related problems declined 77 percent in the treatment group.<sup>30</sup>

Scientific Learning's *Fast ForWord* game-based program for retraining kids with reading problems conducted National Field Trials using 60 independent

professionals at 35 sites across the USA and Canada. Using standardized tests, each of the 35 sites reported conclusive validation of the program's effectiveness, with 90 percent of the children achieving significant gains in one or more tested areas.<sup>31</sup>

Again and again it's the same simple story. Practice – time spent on learning – works. Kids don't like to practice. Games capture their attention and make it happen. And of course they must be practicing the right things, so design is important.

The US military, which has a quarter of a million 18-year-olds to educate every year, is a big believer in learning games as a way to reach their Digital Natives. They know that their volunteers expect this: “If we don't do things that way, they're not going to want to be in our environment.”<sup>32</sup>

What's more, they've observed it working operationally in the field. “We've seen it time and time again in flying airplanes, in our mission simulators.” Practical-minded Department of Defense trainers are perplexed by educators who say, “We don't know that educational technology works – we need to do some more studies.” “We *know* that the technology works,” they retort. We just want to get on with using it.”<sup>33</sup>

So, today's neurobiologists and social psychologists agree that brains can and do change with new input. And today's educators with the most crucial learning missions – teaching the handicapped and the military – are already using custom-designed computer and video games as an effective way of reaching Digital Natives. But the bulk of today's tradition-bound educational establishment seem in no hurry to follow their lead.

Yet these educators know that something is wrong, because they are not reaching their Digital Native students as well as they reached students in the past. So they face an important choice.

On the one hand, they can choose to ignore their eyes, ears and intuition, pretend that the Digital Native/Digital Immigrant issue does not exist, and continue to use their suddenly-much-less-effective traditional methods until they retire and the Digital Natives take over.

Or they can choose instead to accept the fact that they have become Immigrants into a new Digital world, and to look to their own creativity, their Digital Native students, their sympathetic administrators and other sources to help them communicate their still-valuable knowledge and wisdom in that world's new language.

The route they ultimately choose – and the education of their Digital Native students – depends very much on us. ●